

ON THE JAW AND LINGUAL MEMBRANE OF NORTH AMERICAN
TERRESTRIAL PULMONATA.

BY W. G. BINNEY.

In his work on the "Terrestrial Air-breathing Mollusks of the United States," my father paid great attention to the jaws and lingual membranes, figuring those of all the species which he could obtain. In continuing my father's labors on the same subject, I have described and figured those of many other species. Thus, in a certain sense, it may be said that a great deal is known of these organs in our land shells. Unfortunately, however, these figures and descriptions have become of comparatively little value now that the study of this subject has assumed such importance. They do not give in sufficient detail the character of the individual teeth, however correct an idea they may give of the general arrangement of the teeth upon the membrane. I have, therefore, been induced to review the whole subject, and present it in a manner which will be of value as throwing light upon classification.

The following pages contain the result of my re-examination of the lingual membranes collected by me during the last thirty years. I regret that the collection is not more perfect, but there seems little chance of my making it more so, especially as to the rarer and more inaccessible species. I have decided, therefore, to publish at this time what material I have.

Before commencing my description, I will give some general remarks on the organs treated of in my paper, and on their value for the purpose of classification, and on the bibliography of the subject.

GENERAL REMARKS.

As many of my readers are quite unfamiliar with the subject, especially most of those who have so largely contributed specimens for examination, I will describe in detail the position of the organs and the method adopted for their study.

On holding up against the light an individual of *Helix thyroides* in one hand, and offering to him with the other some food (a piece of carrot is always acceptable), one can readily see with the naked

eye the two organs here treated of. Above the external opening of the month, through the transparent tissue of the head, is seen a small, arched, reddish, free instrument, which appears to rise and fall as if used in cutting off morsels of food. This is the jaw.

On the floor of the mouth is the lingual membrane, occupying about the position of the human tongue. Its color is too nearly the same as that of the head to afford any strong contrast, but, with close attention, it will be detected by its glistening silvery appearance, as it works backward and forward.

The use of the tongue seems to be to rasp the food and also to force it back into the œsophagus.

More detailed description, fully illustrated by figures, of the position of these two organs, will be found in the chapters on Special Anatomy in the first volume of the "Terrestrial Air-breathing Mollusks of the United States."

METHOD OF EXTRACTION.

On opening the head of *Helix thyroides* from above, one readily notices at the extreme anterior part, close against the outer integument, a prominent oval body. This is called the buccal mass. It is easily cut away from the animal, and will be found to contain both jaw and lingual membrane. They can be removed by fine scissors or knives from the buccal mass in the larger species, but in the smaller species, the method usually employed is putting the whole buccal mass in a watch crystal full of a strong solution of caustic potash. Allowing it to remain for several hours, the potash will destroy all of the buccal mass, and leave the jaw and lingual membrane perfectly clean and ready for examination. They remain attached, if the solution is not too strong, showing a connection between the two. They must first be well rinsed in clean water, in another watch crystal, before examination. Another more expeditious process is to place the whole buccal mass in a test-tube, with the solution of potash, and boil it for a few seconds over a spirit lamp. Pouring the contents of the test-tube into a watch crystal, the lingual membrane attached to the jaw will be readily seen by a pocket lens. If the species be very small, as *Paluta striatella* for instance, its whole body may be thrown into the solution. Still more minute species, as *Zonites milium* for instance, may be treated in this way: crush the whole shell between

two glass slides, wash away the particles of the broken shell in a few drops of water, still keeping the body of the animal on the slide; when clean, drop on it the caustic potash and boil it by holding the slide itself over the spirit lamp.

ON MOUNTING.

For the purpose of examination, the jaw and lingual membrane may be simply mounted in water and covered with thin glass. One must be sure to spread out the lingual membrane, not have its upper side down, and it will be well to cut it transversely in several places, as the teeth are beautifully shown, and often stand detached, on the edges of the cut.

For preservation for future study I hesitate to recommend any process, as I know of none which has been tried for a sufficiently long time. I have myself lost many specimens by imperfect mounting. Canada balsam, formerly used, ruins the membrane by rendering it too transparent. The glycerine mounting fluids, now in use, certainly preserve a membrane for several years, but they have not been tried many years.

ON THE JAW.

The jaw and lingual membrane, having been mounted, must now be examined under the microscope.

The jaw will be found to vary greatly in its characters in the different genera. It is either in one single piece (pl. XVI., fig. 1); in one single piece with an accessory quadrate piece attached to its upper margin; or in separate, detached pieces, free on their lower edges, usually soldered together into one single piece above (pl. XVI., fig. 13). It differs also in being with (pl. XVI., fig. 3), or without (fig. 6) a median beak-like projection to its cutting edge; also in its ends being more or less acuminate; but still more by the presence or absence of striæ or rib-like processes on its anterior surface. When present, the ribs are found in every degree of development, passing quite across the jaw and denticulating one or both margins (pl. XVI., fig. 8), or only developed on the lower portion of the jaw, and crenellating the lower margin. The ribs are often almost obsolete, or represented by wrinkles or coarse striæ. They are present on the anterior

surface of the jaw only, or on both anterior and posterior surfaces. They are distant, narrow, stout, few (fig. 8); or crowded, broad, stout, and numerous (fig. 14). Their number is within certain limits inconstant in the same species. They sometimes are very broad, and seem like separate plates soldered to the anterior surface of the jaw, or to be formed by a folding of the jaw upon itself (fig. 12). When this appearance of folding into plates is given, it will generally be found that the plait-like sections are actually separated by distinct, but delicate ribs. When this form of ribs is found, they are either vertical or inclined obliquely towards the median line of the jaw. Sometimes this last arrangement is developed to such a degree that the delicate ribs meet before reaching the bottom of the jaw, and a triangular compartment is left at the upper centre of the jaw, its base being upward (fig. p.). This form of jaw is usually thin and membranous.

When the jaw is striated and not ribbed, the striæ are vertical, or they converge towards the median line (fig. p.). There are often transverse striæ also, and transverse lines of re-enforcement (pl. XVI., fig. 3).

The upper margin of the jaw is often extended into a stout membranous attachment, apparently of the same material and consistency as the jaw itself, and showing the same continuity of structure by the striæ of the jaw extending into it without interruption. This is not the accessory quadrate plate mentioned above.

The jaw is found in every degree of consistency, from very thick to quite membranous and almost transparent.

The cutting margin of the jaw is smooth, crenellated, or denticulated. It is simply concave, or furnished with a more or less developed beak-like median projection.

In shape the jaw ranges from scarcely arcuate, long, low, to horseshoe-shaped, short, high.

It will be seen below that these peculiarities of the jaw, taken in connection with the characters of the lingual membrane, appear to furnish reliable characters for classification.

THE LINGUAL MEMBRANE.

In placing the lingual membrane under the microscope, we at once perceive that it is (at least in most of our genera) a long,¹ narrow, ribbon-like organ, whose whole surface is covered with numerous small tooth-like processes, whose reflected apices are pointed, the points directed towards the œsophagus, to which, as stated above, they serve to move the food, as well as to perform a rasp-like mastication. These teeth are arranged in two series of rows, one running longitudinally, the other transversely.

On careful examination it will be seen that all the teeth of each successive longitudinal row are of the same form,² but that there are several types of teeth in the different parts of each transverse row. Three of these types are found, the *central* tooth, the teeth on either side of the central, called *laterals*, and the teeth extending from the laterals to the outer margins of the membrane, called *marginals*. The change from the single central to the laterals is usually abrupt, but from the laterals to the marginals it is usually gradual, so that there are several teeth intermediate between the two, which may be called *transition* teeth. The transverse rows of teeth are similar on each side of the central tooth, so that it is necessary to figure only one-half of one transverse row with its central tooth to give an idea of the whole transverse row, or indeed, of the whole membrane, as all the longitudinal rows, as stated above, have similar teeth.

These transverse rows differ in the various genera as to their direction, either straight, oblique, or curving, or a combination of these directions.

Of the three types of teeth, central, lateral, and marginal, one or more may be wanting. Their number, however, is approximately constant in different individuals of the same species, so that, as a specific character, the count of the teeth on one transverse row is usually given; thus in *Zonites inornatus* I find about

¹ It is very broad in *Orthalicus Liguus*, some subgenera of *Achatinella*, some *Bulimuli*, etc.; in some subgenera of *Cylindrella* it is very narrow.

² Even in case of malformation this holds true. I have often found a misshapen, or otherwise abnormal tooth, repeated down the whole length of the membrane, or even that a tooth may be entirely wanting in its whole length.

23—1—23 teeth, that is, 23 teeth on each side of the central tooth, making 47 teeth in the entire transverse row.

The characters of the individual teeth vary greatly in the various genera, especially in some of the genera foreign to our limits. In most cases, however, there are two distinct types of teeth, the *quadrate* and *aculeate*. The former is shown in pl. III., fig. 12, *a, b, c, d*, is the portion of the tooth which rests upon the membrane; I have called it the *base of attachment*. It varies in its proportional length, and in the greater or less expansion of the lower lateral angles. The upper margin of this base of attachment is broadly reflected; *e* marks the reflected portion, which I term the *reflection*. It is usually tricuspid, the *median cusp* being much longer than the *side cusps*. These last are sub-obsolete in the species figured, but in figure 7 *a* of the same plate these side cusps are more fully developed. All the cusps are in most cases surmounted by distinct *cutting points*; *i* is the *median cutting point*, *g g* the *side cutting points*. These cutting points are not always present on the side cusps, and, even when present, are sometimes not readily detected. Indeed, this is the most difficult point of study of the whole membrane. The cusps and cutting points vary in development in the various species, and somewhat so in different portions of the same membrane.

The other type of tooth (pl. XVII., fig. 3 *b*), which I call *aculeate*, differs in not having a quadrate base of attachment, but usually one of a somewhat sole-like form. Its upper margin is not reflected, but from its whole surface springs a single large cutting point, usually thorn-shaped, but sometimes more spine-shaped. The apex of the cutting point is sometimes bifid, or even trifid, even in the same genus.

Of these two types, quadrate and aculeate are all the teeth now known. Of the quadrate type many and dissimilar forms are known, but all have the quadrate base of attachment.

The characteristics of central, lateral, and marginal teeth are given under each genus or subgenus.

I use the term *upper* and *lower* to describe the figure I give of the base of attachment. More properly I should say *posterior* and *anterior* to describe their position on the membrane.

ON CLASSIFICATION.

The characters of the jaw, combined with those of the lingua membrane, furnish reliable bases of classification. They have been considered of various weight by different writers. I here propose to treat them as guides only to the greater division of the Pulmonata.¹ In grouping the various genera it will be necessary to include *all*, both American and foreign to America, in order to properly appreciate the value of this grouping.

Taking, therefore, the whole series of known terrestrial Pulmonata, the first grand division is based on the presence or absence of a jaw. Of the former are the following: *Testacella*,² *Daubardia*,³ *Streptaxis*,⁴ *Rhytida*,⁵ *Diplomphalus*,⁶ *Strebelia*?⁷ *Glandina*,⁸ *Petenia*?⁹ *Spiraxis*?¹⁰ *Streptostyla*,¹¹ *Ravenia*?¹² *Streptostele*,¹³ *Cæliaxis*?¹⁴ *Gonospira*,¹⁵ *Gibbus*?¹⁶ *Ennea*.¹⁷

All the above have aculeate marginal teeth; the lateral teeth are always absent; the centrals in some of the genera.

The following genera have quadrate marginal teeth: *Onchidium*,¹⁸ *Onchidella*,¹⁹ *Peronia*,²⁰ *Buchanania*?²¹

¹ I must not be understood to propose a system of classification. I merely place the genera into certain groups, independent of their divisions into families.

² Heynemann, Malak. Blatt. X., pl. II., fig. 5.

³ Goldfuss verh. Naturh. Vereins der preuss. Rheinl. und Westphales, 13th year, 1856, pl. VI., fig. c. c¹.

⁴ Heynemann, Malak. Blatt. XV., pl. IV., fig. 2.

⁵ Semper, Nachr. der deut. Malak. Gesellschaft II., 102.

⁶ Fischer and Crosse, Journ. de Conch. XXI., 21, pl. III., fig. 8.

⁷ Jaw and dentition unknown

⁸ See this paper.

⁹ Jaw and dentition not actually known.

¹⁰ Jaw and dentition not actually known; as restricted, the genus maybe more correctly placed near *Stenogyra*.

¹¹ Fischer and Crosse, Moll. Mex., p. 16, pl. IV., fig. 2.

¹² Jaw and dentition not actually known.

¹³ Heynemann, Nachr. mal. Gesel. I. 20, 177, fig. 5.

¹⁴ Jaw and dentition not actually known.

¹⁵ Bland and Binney, Amer. Journ. Conch. V. 37, pl. XI. fig. 1, pbographed.

¹⁶ No doubt like the last.

¹⁷ Heynemann, Nach. mal. Gesel. I. 20, 177, pl. XX., figs. 3, 4.

¹⁸ Bland and Binney, Ann. Lyc. N. H. of N. Y. X., p. 340, pl. VI., figs. 3-5.

¹⁹ Heynemann, Malak. Blatt. X., pl. III., fig. 13.

²⁰ Quoy, Voy. de l'Astrolabe, pl. XII. ²¹ Jaw and lingual unknown.

The second grand division contains those genera having a jaw. In this division also we find some genera with aculeate, and some with quadrate, marginal teeth.

Of the former are: *Limax*,¹ *Ibycus*,² *Parmacella*,³ *Tennentia*,⁴ *Mariella*?⁵ *Parmarion*,⁶ *Dendrolimax*,⁷ *Phosphorax*?⁸ *Urocyclus*?⁹ [I know nothing of the position of *Othelosoma*, *Aspidorus*, and other problematical genera.] *Vitrina*,¹⁰ *Vitrinoidea*,¹¹ *Vitrinopsis*,¹² *Nanina*,¹³ and all the genera now recognized in its disintegration, *Stenopus*,¹⁴ *Vitrinoconus*,¹⁵ *Macrocyclus*,¹⁶ *Zonites*.¹⁷

The following genera have quadrate marginal teeth. They may be readily grouped by the character of their jaw, which is either in one single piece, in one single piece with an accessory upper quadrate piece, or in numerous pieces.

Those whose jaw is in one single piece may again be subdivided into several groups based on the absence, presence, and peculiarities of the ribs on their jaw. This division, however, is unsatisfactory, as these characters are not always well marked.

(a) Jaw without ribs: *Philomyces*,¹⁸ *Parmella*?¹⁹ *Oopelta*,²⁰ *Anaderus*,²¹ *Sagda*,²² *Patula*,²³ *Polymita*,²⁴ *Hemitrochus*,²⁵ *Helicodiscus*.²⁶

¹ See this paper.

² Heynemann, Malak. Blatt. X. 142, pl. I., fig. 3.

³ Semper, Phil. Archipell. 90.

⁴ Semper, l. c. 1, pl. VI., fig. 17.

⁵ Ib. 12.

⁶ Ib. 9, pl. VI., fig. 16.

⁷ Heynemann, Malak. Blatt. XV., pl. I., fig. 1.

⁸ Jaw and tongue not known.

⁹ Heynemann, Malak. Blatt. 1866, 70, pl. XI., as *Parmarion flavescens*.

¹⁰ See this paper.

¹¹ Semper, l. c. 85, pl. IX., fig. 33.

¹² Ibid. 86, pl. XI., fig. 26.

¹³ Ibid.

¹⁴ Bland, Ann. Lyc. N. H. of N. Y., VIII., 158, fig.

¹⁵ Semper, l. c., 91, pl. XI., fig. 27.

¹⁶ See this paper.

¹⁷ See this paper.

¹⁸ See this paper.

¹⁹ Jaw and lingual dentition unknown.

²⁰ Heynemann, Malk. Blatt. XIV., pl. I., 2.

²¹ Heynemann, Malk. Blatt. X., 138, pl. I., fig. 1.

²² Bland and Binney, Am. Journ. Conch. VI., 177.

²³ See this paper.

²⁴ Bland and Binney, Ann. Lyc. N. H. of N. Y., X., 341, pl. XVI., fig. 1.

²⁵ See this paper.

²⁶ See this paper.

Acavus, *Corilla*, *Caryodes*, *Panda*, *Labyrinthus*, *Caracollus*,¹ *Leucochroa*,² *Cysticopsis*?³ *Plagioptycha*,⁴ *Leptoloma*,⁵ *Anostoma*,⁶ *Anostomella*?⁷ *Tomigerus*? *Boysia*? *Plectostoma*? *Hypselostoma*?⁸ *Achatinella*,⁹ *Clausilia*,¹⁰ *Stenogyra*,¹¹ *Strophia*,¹² *Buliminus*,¹³ *Balea*,¹⁴ *Pupa*,¹⁵ *Vertigo*,¹⁶ *Ferussacia*,¹⁷ *Cæcilianella*,¹⁸ *Geostilbia*? *Azeca*? *Tornatella*?¹⁹ *Zospeum*?²⁰ *Holospira*,²¹ *Eucalodium*?²² *Cælocentrum*,²³ *Lithotis*,²⁴ *Rhodea*, *Megaspira*,²⁵ *Limicolaria*,²⁶ but one species has a ribbed jaw, *Achatina*,²⁷ *Pseudachatina*? *Perideris*? *Columna*?²⁸ *Bulimus* as now constituted has various forms of jaw.

(b) Jaw with decided stout ribs: *Arion*, *Ariolimax*, *Prophysaon*, *Pallifera*, *Veronicella*, *Binneia*, *Hemphillia*, *Helix*,²⁹ *Geomolacus*,³⁰ *Letournexia*,³¹ *Peltella*,³² *Xanthonyx*,³³ *Simpulopsus*,³⁴ *Pfeif-*

¹ See Semper, l. c. No doubt other genera of disintegrated *Helix* will be found to be grouped here. I propose at present to remove from *Helix* all the species not having ribs upon their jaw.

² Bland and Binney, Ann. Lyc. Nat. Hist. of N. Y., X., 220.

³ Bland and Binney, Ann. Lyc. N. H. of N. Y., IX.

⁴ Proc. Ac. Nat. Sc. Phila. 1874, 56.

⁵ Ibid. 58.

⁶ Journ. de Conch., XIX., 261, pl. XI., fig. 4.

⁷ Jaw and dentition unknown.

⁸ Jaw and dentition unknown.

⁹ Bland and Binney, Ann. Cyc. N. H. of N. Y., X., 335, pl. XV., figs.

6, 7.

¹⁰ Troschel, Moquin-Tandon, Lehmann, etc.

¹¹ See this paper.

¹² See this paper.

¹³ But some species have ribs. See Moquin-Tandon, Lehmann, etc.

¹⁴ Moquin-Tandon, Moll. Fr., pl. XXV., fig. 6.

¹⁵ See this paper.

¹⁶ See this paper.

¹⁷ See this paper.

¹⁸ See this paper.

¹⁹ Unknown.

²⁰ Heynemann, Mal. Bl. X., pl. III., fig. 14. Jaw unknown.

²¹ See this paper.

²² See Crosse and Fischer, Journ. de Conch. 1870, pl. V., fig. 1.

²³ Jaw and dentition unknown.

²⁴ Binney, Proc. Phila. Ac. Nat. Sc. 1874, pl. V., fig. 3.

²⁵ Jaw and dentition unknown.

²⁶ Bland and Binney, Amer. Jour. Conch., VII., 181.

²⁷ Von Martens, ed. 2, p. 201.

²⁸ Jaw and dentition unknown.

²⁹ See this paper.

³⁰ Bland and Binney, Ann. of Lyc. of N. H. of N. Y., X., 309, fig.

³¹ Bourignat, Moll. nouv. et lit. VII. 201, pl. XXXIV., fig. 1-7.

³² Jaw apparently ribbed in Férussac's figure, pl. VII. A.

³³ Fischer and Crosse, Moll. Mex., pl. IX., figs. 15, 16.

³⁴ Shuttleworth, Diag., No. 6, p. 147.

feria,¹ *Berendtia*,² and, as stated above, some species now included in *Bulimus*, *Cochlostyla*, *Buliminus*, *Limicolaria*.

(c) Jaw with separate, delicate ribs, usually running obliquely towards the centre: *Gæotis*,³ *Amphibulima*,⁴ *Bulimulus*, *Cylindrella*, *Macroceramus*,⁵ *Pineria*,⁶ *Partula*.⁷

The genera whose jaw is in one piece with an accessory quadrate piece are *Succinea*,⁸ *Omalonyx*,⁹ *Hyalimax*,¹⁰ *Athoracophorus*.¹¹

The genera whose jaw is in separate pieces are *Orthalicus*, *Liguus*, and *Punctum*.¹² I have arranged the American genera in the same manner in the following pages.

BIBLIOGRAPHY.

The principal works referred to are:—

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BINNEY and BLAND. *Land and Fresh Water Shells of North America*. Part I. *Smithsonian Miscellaneous Contributions*. Washington, 1869.

MORSE in *Journal of the Portland Society of Natural History*, 1864.

MOQUIN-TANDON. *Histoire Naturelle des Mollusques Terrestres et Fluviales de la France*. Paris, 1855.

FISCHER et CROSSE. *Etudes sur les Mollusques Terrestres et Fluviales du Mexique et l'Amérique Centrale*. Paris, 1874.

LEHMANN. *Die lebenden Schnecken und Muscheln der Umgegend Stettins und in Pommern*. Cassel, 1873.

¹ Mörch, *Journ. de Conch.*, 1865, 385.

² Crosse and Fischer, *Journ. de Conch.* 1870, pl. V., fig. 11, 12.

³ Bland and Binney, *Ann. Lyc. N. H. of N. Y.*, Vol. X., pl. XI., figs. 1, 5-7.

⁴ *Proc. Phila. Ac. N. Sc.* 1874, pl. VIII., figs. 2, 5, 6. *Pellicula* is a synonym of this.

⁵ See this paper.

⁶ Bland and Binney, *Ann. N. Y. Lyc. N. H.*, X., 22.

⁷ Binney, *Ann. Lyc. N. H. of N. Y.*, XI. 45.

⁸ See this paper.

⁹ *Malak. Blatt.* X., pl. IV., fig. 5, a.

¹⁰ Fischer and Crosse, *Journ. de Conch.* XV., 218, pl. X., figs. 5, 7.

¹¹ Bergh, *verh. kais. kœnig. zoolog. botan. Gesell. in Wien.* XX. 844, pl. XII., fig. 2, 4, 5.

¹² See this paper.

GOLDFUSS. Verzeichniss der bis jetzt in der Rheinprovinz und Westphalen beobachteten Land- und Wasser-Mollusken, nebst kurzen Bemerkungen über deren Zungen, Krefer, und Liebesfeile. From Verhandlungen der naturhistorischen Vereins der preussischen Rheinlande und Westphalens. 13 Jahrgang. Bonn, 1856.

SEMPER Landmollusken. Reisen in Archipel der Philippinen. Wiesbaden, 1873.

HEYNEMANN. Einige Miltkeilungen über Schneckenlungen mit besonderer Beachtung der Gattung *Limax*. From Malakozoologischer Blätter, X. 1862.

VON MARTENS Die Heliceen von JOH. CHRIST. ALBERS. Zweite Ausgabe. Leipzig, 1860.

These are the principal works referred to. The references to shorter papers in various periodicals will easily be understood.

ON MY ILLUSTRATIONS.

I have endeavored to give a good view of the central, lateral, and marginal teeth of each species, with the transition teeth of many of the species. The portion of the membrane chosen is different in the various species of each genus or subgenus, in order that the variations in the form and development of cusps, and cutting points may be shown. Thus on pl. III. fig. 1, *b*, I have selected the part of the membrane where the marginal teeth have a very blunt cusp, while in fig. 4, *b*, they are shown much more graceful. It must constantly be borne in mind that on any one membrane the teeth vary considerably in regard to this point.

In illustrating the general arrangement of the teeth upon the lingual membrane in each genus or subgenus, I have used the woodcuts in the text prepared for my former works and papers, mostly by Mr. Morse, and a few by Dr. Leidy, prepared for my father's work. It must be remembered that these figures do not represent correctly the characters of the individual teeth.

I have also used in the text figures of the jaws of many genera and subgenera, prepared for the Land and Fresh Water Shells of North America, Part I. The jaws of the more recently described genera and subgenera I have myself drawn by camera lucida in pl. XVI.

ON THE VALUE OF THE JAW AND LINGUAL MEMBRANE FOR THE
PURPOSE OF CLASSIFICATION.

It is conceded by all recent students of land shells that for the larger divisions the presence or absence of a jaw, and the aculeate or quadrate form of marginal teeth are reliable characters.

The characters of the jaw and separate teeth of the lingual membrane have also been used in various ways for grouping the genera into families, etc., and even of grouping species into genera. I refrain from any discussion of their value for such purposes, simply because I believe our material is far too limited. It seems as if I can better employ my time in patiently accumulating new facts. I can, however, venture to say that the character of the jaw and teeth seems to be more constant in some genera than in others. It appears, for instance, that in some genera the presence or absence of lateral teeth is not a generic character, though in others it is.

The same may be said of the presence or absence of side cutting points to the centrals and laterals, and the greater or less development of their side cusps; also in the bifurcation or non-bifurcation of the cutting point of aculeate marginal teeth.

It will, I believe, be proved that certain genera are constantly characterized by peculiar form of teeth, while others have a considerable range of variation. I might, perhaps, add that when the genus is numerous in species, there is a much greater chance of finding a varying dentition. If this latter proves true, we shall be obliged to concede that there are certain types of teeth which may be found among species of some of the larger genera, though some of the smaller genera are much more, if not absolutely, restricted to one single type of dentition. I do not venture any further deductions at this time.

Before closing my paper I must return thanks to my many correspondents, who have furnished me specimens for examination during many years. I have already acknowledged their kindness while originally describing the jaw and lingual membrane of each species in the *American Journal of Conchology*, the *Annals of the Lyceum of Natural History of New York*, and the *Proceedings of the Academy of Natural Sciences of Philadelphia*. Most of

those papers¹ were published in connection with my friend, Mr. Bland, without whose aid I never could have had the material to study lingual dentition, especially in the interesting forms foreign to the United States. He has also shown great interest in the progress of the present paper.

Finally, I must acknowledge my many obligations to my young friend, Mr. A. Ten Eyck Lansing, for his most valuable assistance in the preparation of my paper. His observations of most of the lingual membranes, independent of my own, have saved me from many errors, and rendered my work much more reliable.

I will add that all the figures in the plates have been drawn by my own hand from the microscope itself, with the aid of the camera lucida.

BURLINGTON, N. J., Oct. 1874.

A complete catalogue of the species found in North America, from the extreme north to the Rio Grande and to San Diego, here follows. An account of their geographical distribution has been published by me in the Bulletin of the Museum of Comparative Zoology, vol. iii. No. 9, Cambridge, 1873.

The sign † is affixed to the name of species whose jaw and lingual membrane are unknown.

PULMONATA GEOPHILA.

OLEACINIDÆ.

- | | |
|---------------------------------------|----------------------------------|
| † <i>Glandina Vanuxemensis</i> , Lea. | † <i>Glandina bullata</i> , Gld. |
| truncata, Gmel. | † <i>Texasiana</i> , Pfr. |
| † <i>decussata</i> , Desh. | |

HELICIDÆ.

VITRININÆ.

- | | |
|--|-----------------------------------|
| <i>Macrocyclus Vancouverensis</i> , Lea. | <i>Macrocyclus Voyana</i> , Newc. |
| † <i>sportella</i> , Gld. | <i>Duranti</i> , Newc. |
| <i>conca</i> , Say. | |

¹ A complete list of all these papers may be had of the American Naturalist Agency, Salem, Mass.